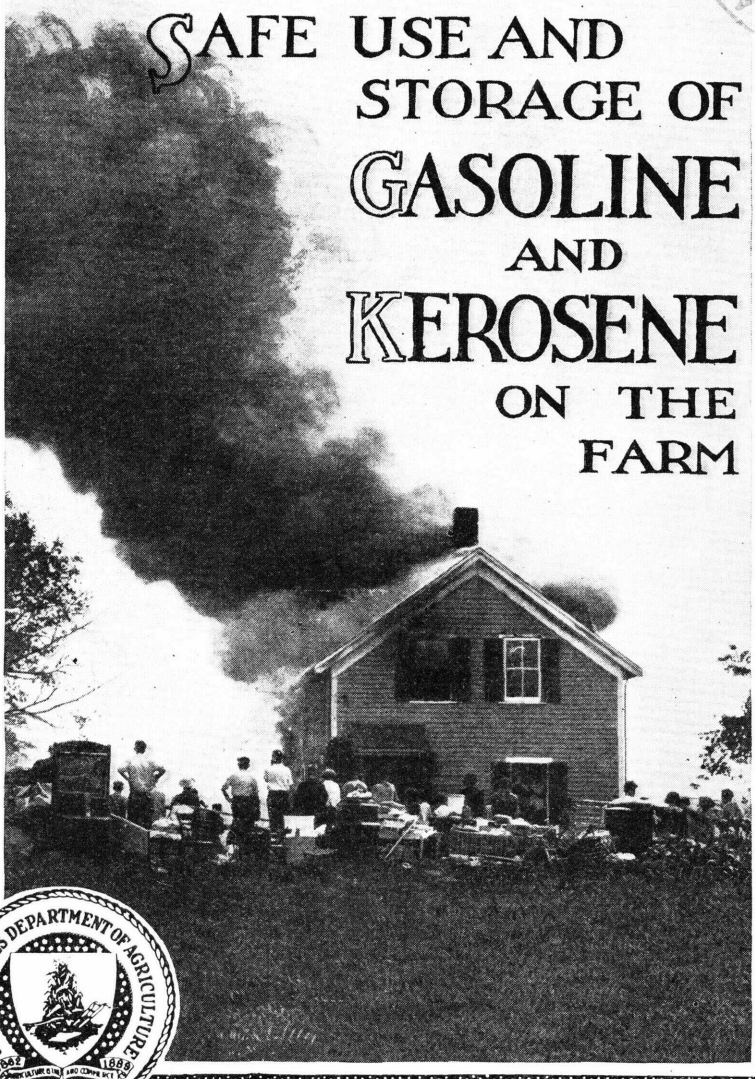
U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1678

SAFE USE AND STORAGE OF GASOLINE AND KEROSENE ON THE FARM



CARELESSNESS IN USING AND STORING gasoline, kerosene, and other petroleum products causes an average fire loss of approximately $6,750,000 annually on farms of the United States.

Gasoline and kerosene, as well as other flammable liquids, are always potentially dangerous. Lives and property may be reasonably safeguarded against this fire and explosion hazard, however, by the proper storage and the careful handling and use of these liquids. This bulletin points out the most common hazards, and the precautions which should be observed. It also gives information on extinguishing gasoline and kerosene fires.

The United States Department of Agriculture, in an effort to reduce the extensive loss of both life and property as the result of fires on farms, is cooperating with the National Fire Protection Association, with executive offices at 60 Batterymarch Street, Boston, and other organizations and associations interested in fire prevention.

Washington, D. C.

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SAFE USE AND STORAGE OF GASOLINE AND KEROSENE ON THE FARM [1]

Issued by the *Bureaus of Chemistry and Soils, Agricultural Engineering,* and *Agricultural Economics,* in cooperation with the *National Fire Protection Association* [2]

CONTENTS

FARM FIRE LOSS FROM THE CARELESS USE OF PETROLEUM AND ITS PRODUCTS

GASOLINE, KEROSENE, and other petroleum products as a rule rank sixth among the causes of fires on farms.[3] Excluding the loss attributed to unknown causes, it has been responsible over a 10-year period for 5½ to 7½ percent of the annual farm-fire loss.[4] In other words, the estimated fire loss on farms caused by the careless use and storage of these products is between $5,500,000 and $7,500,000 annually.

Probably several hundred people on farms are killed or seriously burned each year from the careless handling and storage of gasoline and kerosene.

While gasoline and kerosene, as well as other flammable liquids, are always potentially dangerous, lives and property may be reasonably safeguarded against this fire hazard by the proper storage and the careful handling and use of these liquids.

[1] This bulletin was prepared by Harry E. Roethe, senior engineer, of the Chemical Engineering Research Division, Bureau of Chemistry and Soils, chairman of the subcommittee of the farm-fire protection committee on the handling and storage of gasoline and kerosene. The other members of this subcommittee were Clarence Goldsmith, of the National Board of Fire Underwriters, and George F. Lewis, formerly deputy fire marshal of the Province of Ontario.

[2] David J. Price, the chairman, and Harry E. Roethe, the secretary, both of the Bureau of Chemistry and Soils; Wallace Ashby, Bureau of Agricultural Engineering; and William H. Rowe, Bureau of Agricultural Economics, are representatives of this Department on the farm-fire protection committee of the National Fire Protection Association, which assisted in carrying on investigations and in supplying valuable data for this bulletin. The committee membership includes representatives of interested agencies in the United States and Canada.

[3] According to Statistics of the National Board of Fire Underwriters.

[4] Estimated by the farm-fire protection committee to be approximately $100,000,000 annually.

FLAMMABILITY OF GASOLINE AND KEROSENE

All grades of gasoline are highly flammable and dangerous. They should always be treated as such.

Gasoline has been called "liquid dynamite" because of the explosive violence which results from the ignition of gasoline vapor mixed with air in certain proportions. The various grades of gasoline differ somewhat in chemical and physical properties. The better grades are much more hazardous to handle than others. As they are much more volatile, they mix with air in larger proportions and pass into vapor form (evaporate) more rapidly.

Gasoline vapor is heavier than air; consequently it will float along near the ground, like an invisible stream, for considerable distances. In a lean mixture (a little less than 2 percent) 5 gallons of gasoline would produce 8,000 cubic feet of burnable or mildly explosive gas (gas-air mixture), or enough to fill a room having the dimensions 20 by 40 by 10 feet. If ignited, and if no heat is lost, and the products of combustion are at atmospheric pressure, this mixture would expand to six or seven times the initial volume of air and gas vapor, with destructive results.

As with other gases and vapors, before an explosion of gasoline vapor can occur a definite proportion of air and gasoline vapor must be present. In 100 parts by volume of air and gasoline, an explosion will not take place if there is less than 1 or more than 6 parts of gasoline vapor. In other words, the explosive range is between 1 and about 6 percent of gasoline vapor. This range of explosibility is narrow as compared with that of many other mixtures of combustible gases and air; nevertheless in the lower limit there is a very small proportion of gasoline vapor, indicating the great importance of not allowing even a little gasoline to be exposed in a room or confined space.

Kerosene (lamp oil or coal oil), unlike gasoline, is not highly flammable. When heated, however, it gives off dangerous vapors which are capable of forming explosive mixtures with air. Generally kerosenes have flash points [5] above 100° F., whereas the flash points of gasoline range down to 0°, or lower.

DANGER OF STARTING AND REVIVING FIRES WITH GASOLINE OR KEROSENE

With considerable regularity the press contains news items of lives and property destroyed as a result of an attempt to start or revive a fire in a stove or a furnace with flammable liquids, generally kerosene (fig. 1). This practice is dangerous, but it is followed to an alarming extent. The reason must be either ignorance or the willingness to take a chance.

The hazard of fire from the burning of the liquids themselves is serious, but the hazard of ignition of the explosive gases formed is doubly serious. The safe rule to follow is never try to start or revive a fire with gasoline or kerosene.

[5] The temperature at which flammable vapor given off from fuel oil will ignite temporarily, or flash.

THE SAFE WAY TO HANDLE OIL LAMPS, HEATERS, STOVES, INCUBATORS, BROODERS, AND LANTERNS

Kerosene lamps, heaters, stoves, incubators, brooders, and lanterns should be carefully handled. They should never be filled while burning. In extinguishing lighted lamps, lanterns, and heaters turn down the wick a little and put out the flame by blowing over the top of the burner. It is dangerous to blow out the flame from underneath or to turn the wick down very low.

Wicks and burners should be kept clean. Boil the burners occasionally in soda lye or soap. An explosion may result from defective wicks which do not entirely fill the wick tube section of the burner.

FIGURE 1.—Never start or revive a fire with gasoline or kerosene.

Such wicks permit free communication between the flame and the space above the oil in the reservoir.

Kerosene stoves should be provided with a drip pan under the burners.[6]

Kerosene lamps should not be made of glass. They should be of metal, with broad, metal bases. Lamp shades should be of material that will not burn. Never place lamps near the edge of a table or near curtains.

Lanterns should be free from leaks, and lighted lanterns when not being carried should be hung on substantial hooks or supports out of the wind, away from cobwebs and other combustible materials, and at a height sufficient to insure protection against damage or disturbance.

Do not place kerosene lamps or lanterns near stoves or in other warm places. The heating of the kerosene in the receptacle forms vapors that cause "flaring."

[6] Regulations of the National Fire Protection Association for small heating and cooking appliances.

Do not carry lighted oil heaters or portable stoves about the house. Keep them at a safe distance from combustible material. Children should be cautioned about playing near them or upsetting them.

Brooders should be placed in an isolated location. It is dangerous to operate them in the house or barn. Overheating should be guarded against.

Although the fire hazard from incubators is not considered as great as that from brooders, they should be operated with care, especially when in the home. Guard against overheating. Use brooders and incubators which bear the label of and are listed by the Underwriters' Laboratories.

HAZARDS OF CLEANING WITH GASOLINE AND OTHER VOLATILE LIQUIDS

Cleaning with gasoline, benzine, and other flammable, volatile liquids is distinctly hazardous and should not be practiced, especially indoors. During cleaning operations vapors are given off which

FIGURE 2.—Use a nonflammable liquid such as carbon tetrachloride for drycleaning at home.

may form explosive mixtures with the air. All that is needed then to produce an explosion is a source of ignition, such as an open flame from lighted matches, kerosene lamps, stoves and heaters, gas jets, mantles, or burners; a lighted cigar, cigarette, or pipe; a metallic spark, an electric spark, or a static spark. Many explosions with loss of life have resulted from the ignition of these vapors by open flames and electric sparks.

Serious explosions and fires have also resulted from the ignition of gasoline vapors, both indoors, and outdoors, by static sparks caused by the rubbing of fabrics and kid gloves on the hands with the liquid. In performing what they thought the harmless task of washing silk dresses and kid gloves with gasoline, these persons did not realize that they were exposing themselves to a serious explosion and fire hazard.

If it is necessary to do any "dry-cleaning" at home, a nonflammable liquid, such as carbon tetrachloride, should be used in small quantities (fig. 2). Carbon tetrachloride in any considerable quantity should be used out of doors as it is toxic (slightly anesthetic). Persons have been overcome by using only a gallon of it in a closed room.

Other volatile oil solvents, sold under various trade names, with a flash point approximately the same as that of kerosene, are now being used to some extent for dry-cleaning purposes in the home. They should be used out of doors, away from flame or sparks that might cause ignition, and they should be used only in the daytime.

HAZARDS OF SPRAYING DISINFECTANTS

Spraying disinfectants in the home for the purpose of killing flies, moths, and ants is now a common practice. Most of these liquids, if not all of them, are flammable. Spraying, therefore, should not be done in the presence of an open flame or a lighted cigar, cigarette, or pipe, or other source of ignition, and the container holding the liquid should be kept closed and away from heat.

HAZARDS OF USING QUICK-DRYING PAINTS AND LACQUERS IN THE HOME

Spraying quick-drying enamels, lacquers, or finishes in the home has created a new and insidious explosion and fire hazard. Pyroxylin lacquers, brushing lacquers containing pyroxylin, and, as a matter of fact, most materials sold under this designation, contain amyl acetate, alcohol, and similar liquids which are highly flammable.

The vapor formed by these lacquers and finishes is heavier than air and highly flammable. It falls to the surface of the ground and may be carried considerable distances. If the proper mixture of vapor and air is present as well as a source of ignition, such as an open flame, a lighted pipe, cigar, or cigarette, a static spark, a metallic spark, or an electric spark, an explosion will result. These vapors may even flash back to the user from a flame located at a seemingly great enough distance for safety.

In general, this hazard can be guarded against by adequate ventilation. The application of these quick-drying paints and lacquers either by sprayers operated by hand or by those attached to vacuum cleaners should, therefore, be carried on out of doors whenever possible, so that the vapors will be quickly dissipated and carried away in the open air. If of necessity spraying is carried on indoors, every precaution should be taken to insure that there are no open lights, fires, sparks, or other sources of ignition nearby and that the windows and doors are open. Smoking should be strictly prohibited.

HAZARDS OF GASOLINE LIGHTING AND COOKING SYSTEMS

In gasoline lighting and cooking systems many hazards can be introduced by faulty design and construction of equipment, such as corrodible material, improperly made joints, and valves of poor design. Only the best and most reliable types of this equipment should be used, such as those which have been tested and listed by the Underwriters' Laboratories, or other well-recognized authorities. Even then certain inherent hazards are possible. The installation should be in strict accordance with the manufacturer's directions and with the recommendations [7] of the National Fire Protection Association.

[7] Regulations of the National Board of Fire Underwriters for the Installation, Maintenance, and Use of Gasoline Vapor Gas Machines, Lamps, and Systems as Recommended by the National Fire Protection Association, edition of 1926; and Regulations of the National Board of Fire Underwriters for the Installation and Operation of Compressed Gas Systems Other than Acetylene for Lighting and Heating as Recommended by the National Fire Protection Association, edition of 1933.

With the operation of this equipment the hazard of explosive vapors is again introduced. The tanks should be filled carefully, and only during the daytime. They should never be filled in the vicinity of an open flame or other source of ignition.

HAZARDS OF AUTOMOBILES, TRUCKS, TRACTORS, AND STATIONARY ENGINES

Stationary and automotive engines may backfire when started. If this happens in the vicinity of combustible materials or explosive gases and dusts a fire may result. Combustible materials should be kept away from such equipment even when in apparently normal operation, because there is always the chance that a fire may be caused by an overheated or faulty muffler, hot or burning carbon deposits, and faulty ignition. It is dangerous, therefore, to house or use internal-combustion engines or automotive equipment so driven, in barns and granaries.

Do not start automobile or other gasoline engines in a closed garage or other building. (This precaution does not apply to engines equipped with a fixed exhaust to the outside of the building.) In starting such engines it frequently happens that the mixture is too rich. As a consequence, deadly carbon monoxide (CO) is given off. This gas in very small quantities is fatal to human life. Furthermore, the fact that it is odorless and colorless and cannot be detected by the sense of smell and the sense of sight makes it doubly dangerous. Before starting engines in confined spaces always open doors and windows in order to provide ventilation and permit the removal of carbon monoxide.

Cleaning automobiles, tractors, and stationary engines with gasoline is dangerous. The vapor produced presents an explosion hazard, the source of ignition readily being supplied by an open flame, a lighted cigar or cigarette, static electricity, the ignition system of the engine, or a spark caused by striking two pieces of metal together.

HAZARDS OF POURING GASOLINE FROM ONE CONTAINER INTO ANOTHER

Dangerous vapors are given off when gasoline is poured from one container into another or when the liquid is exposed to the air, thus forming an explosive mixture of vapor and air which may be ignited very easily. Consequently such pouring should not be done near open flames or lights, or near engines and motors while they are running. Smoking, and electric and metallic sparks also are sources of ignition that should be guarded against.

Another source of ignition is static electricity. Static electricity can be generated by gasoline in a number of ways. It is generated, for example, by gasoline flowing through either a metal pipe or a rubber hose, by gasoline being poured from one container into another or being filtered through chamois, and by gasoline swishing about inside a tank or tank wagon. Unless the containers or other equipment are grounded, the static charge accumulates and eventually escapes to the ground by jumping across or bridging nearby points or areas. A spark or series of sparks is thus produced, and an explosion of the vapor may result. To prevent such an occurrence the containers or other equipment should be grounded or be in contact with the ground.

In pouring gasoline from a can or a drum into another container with a funnel, for example, a simple expedient is to keep the mouth of the container from which the gasoline is being poured in contact with the funnel, and the funnel in turn in direct contact with the receptacle being filled, the latter resting on the ground. When filling the tank of the tractor, automobile, or gas engine it is a simple matter to keep the metal nozzle of the hose in contact with the mouth of the tank, thus preventing the passage of a static spark. An additional precaution is to touch the filling nozzle to some metal part of the automobile or tractor before placing it in the mouth of the tank.

HAZARDS OF FUEL-OIL BURNERS

Although on farms the use of oil for heating the home is limited, the subject is of sufficient importance to be touched upon in this bulletin.[8]

As with heating apparatus of other kinds a fire hazard is associated with domestic oil burners. Fire records in the urban districts indicate that the greatest number of fires with property damage attributed to domestic oil burners are caused by the failure of automatic shut-off valves to function and thus stop the supply of oil; loose connections and leaking pipes; back-firing; defective burners; and careless operation.

It is of great importance, therefore, that only domestic oil burners be selected or used which have been tested by and bear the label of the Underwriters' Laboratories. This label is assurance to the buyer or user that the oil burner bearing the label has been safeguarded to a reasonable degree and is so made that it may readily be installed in accordance with the recommendations of the National Fire Protection Association.

Oil-burning systems involve the installation of tanks, piping, the burner proper, and, in most cases, electrical wiring. In handling all this equipment, the recommendations of the National Fire Protection Association[9] and the National Electrical Code should be followed. The installation should be made only by competent, reliable workmen, strict attention being paid to the manufacturer's instructions. The principal object to keep in mind when installing tanks and piping for an oil burner is the complete delivery of the oil to the burner.

The equipment, once installed, should receive adequate and intelligent attention. When in operation, the oil burner should be looked over at least once a day, and preferably oftener. Care should be taken to see that automatic devices or provisions to prevent flooding of the burner are always in good working order.

Oils used in domestic oil burners should have a flash point of not less than 100° F. or the local legal minimum.

Range oil burners should be substantially constructed. The fuel container should be well supported, not too close to the stove, and so located as to be not accidentally hit or damaged. Manufacturer's directions should be rigidly followed in installing these devices.[10]

[8] For further information see U. S. Dept. Agr. Circ. 406. Oil Burners for Home Heating.

[9] Regulation of the National Board of Fire Underwriters for the Installation of Oil Burning Equipments as recommended by the National Fire Protection Association, edition of 1934, with amendments of 1936.

[10] Suggested Ordinance Regulating Range Oil Burners. Published by the National Fire Protection Association, 1934.

PROPER STORAGE OF GASOLINE AND KEROSENE [11]

It is very important that the farmer who uses gasoline and kerosene on his farm give serious consideration to their storage.

GASOLINE

Gasoline should never be stored or handled in open containers in any building. All containers for gasoline should be red, and the word GASOLINE should be painted on them in a conspicuous manner.

In buildings (except a special storage room or fire-resistive building) gasoline should be stored in an approved sealed container or safety can (fig. 3), the total quantity thus stored not to exceed 1 gallon.

Outside buildings, gasoline should be stored in substantially constructed steel drums (fig. 4) of not more than 60 gallons capacity, equipped with a pump, the drum or drums being at least 75 feet from the nearest building, or in an approved underground tank (fig. 5) equipped with an approved pump, the tank being at least 10 feet from the nearest building. Such tanks may be had in capacities ranging upward from 110 gallons.

PLACING OF TANKS

The top of an underground tank should not be less than 2 feet below the surface of the ground, and should be below the level of any piping to which the tank may be connected. Instead of being buried 2 feet underground, the tank may be buried under 12 inches of earth, and a cover of reinforced concrete at least 6 inches in thickness provided. This cover should extend at least 1 foot beyond the outline of the tank in all directions and should be placed on a firm, well-tamped earth foundation.

A tank that cannot be entirely buried should be covered over with earth to a depth of at least 2 feet, with a slope on all sides not steeper than 1½ feet horizontal to 1 foot vertical.

CONSTRUCTION OF TANKS

Tanks, including top, sides, and bottom, should be constructed of open-hearth steel or wrought iron of a thickness not less than that specified in table 1. No seconds should be used. All material lighter than No. 7 U. S. Standard Gage should be galvanized.

TABLE 1.—*Thickness and weight of metal for gasoline and kerosene tanks*

Capacity (gallons)	Minimum thickness of material	Pounds per square foot
	Gage [1]	*Pounds*
1 to 285	16	2.50
286 to 560	14	3.125
561 to 1,100	12	4.375
1,101 to 4,000	7	7.50

[1] U. S. Standard.

[11] The material on the placing, construction, and venting of tanks, and on pumps and piping was taken from Suggested Ordinance Regulating the Use, Handling, Storage, and Sale of Flammable Liquids and the Products Thereof, edition of 1937; published by the National Fire Protection Association.

FIGURE 3.—Safety can for storing small quantities of gasoline.

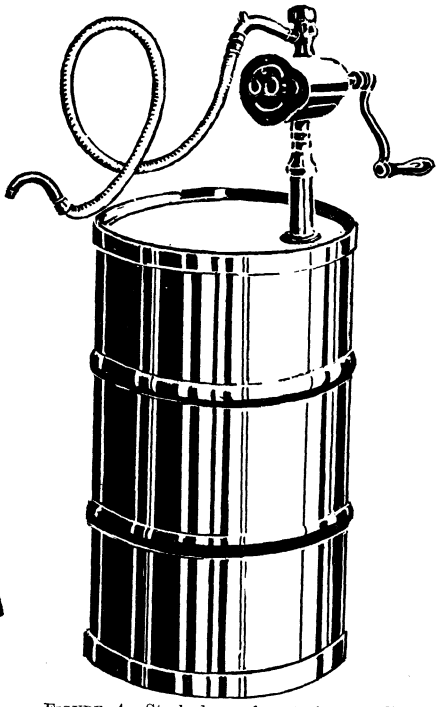

FIGURE 4.—Steel drum for storing gasoline.

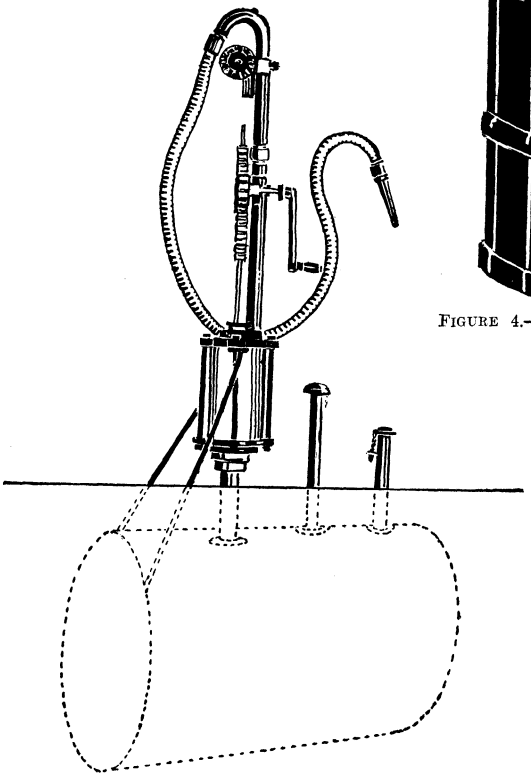

FIGURE 5.—Underground tank and pump for storing gasoline.

Tanks should be riveted, welded, or brazed, and they should be soldered, caulked, or otherwise made tight. They should also be thoroughly coated on the outside with tar, asphaltum, or other suitable rust-resisting material. All pipe connections should be made through flanges or metal reinforcements securely riveted, welded, or bolted to the tank, and should be absolutely tight. All openings should be gastight, except the breather vent, which should be screened.

VENTING OF TANKS

An open galvanized-iron vent pipe arranged for proper draining, or an automatically operated vent, should be provided for every tank that contains flammable vapor. The lower end of the vent pipe should not extend through the top into the tank for a distance of more than 1 inch.

Vent openings should be screened (preferably by 40 by 40 but not less than 30 by 30 noncorrodible wire mesh or its equivalent). The area should be sufficient to permit escape of air or vapor during the filling operation. Vent pipes should be provided with weatherproof hoods.

PUMPS

Flammable liquids should be drawn from tanks by pumps so constructed as to prevent leaking or splashing.

PIPING

All piping used in systems for flammable liquids should be of the standard full-weight wrought-iron, steel, or brass type (for working pressures less than 100 pounds per square inch). No pipe less than one-half inch in internal diameter should be used.

Outside piping within 5 feet of the ground level should be protected against any mechanical injury. Inside piping should be rigidly supported.

All pipes carrying flammable liquids should pitch toward the tanks without any traps or pockets and should enter tanks at the top.

OVERHEAD SHELTER

Drums and tanks may be provided with a simple, inexpensive, overhead shelter to afford protection against the weather. Such a shelter will not give opportunity for the accumulation of gasoline vapor, as would an enclosed structure.

KEROSENE

Kerosene should not be stored or handled in open containers in any building.

Only moderate quantities of kerosene should be stored in buildings, and it should be stored only in closed containers or substantial drums equipped with a pump. The containers should be kept at a safe distance from furnaces or other heating appliances and from flammable rubbish. Kerosene for immediate use should be kept in a can which is entirely different in size and shape from the container in which gasoline is stored. This will greatly lessen the possibility of gasoline being used by mistake, especially at night.

Large quantities of kerosene should be stored outside buildings in substantial drums equipped with a pump or in an underground tank equipped with a pump. (See details regarding construction and placing of underground tanks and appurtenances under Gasoline, pp. 8 to 10.)

It is important that cans, barrels, and drums holding kerosene be kept clean and that the word KEROSENE be painted on them in a conspicuous manner.

DRAWING GASOLINE AND KEROSENE

Gasoline and kerosene should never be drawn or handled in the presence of open flames or fire. If it is necessary to draw them at night, light should be afforded by electric flashlight or incandescent electric lamps installed in compliance with the National Electrical Code.

Drums for gasoline and kerosene should be provided with caps, plugs, or bungs, and these should always be replaced immediately after the liquid has been drawn from the container.

Smoking or the use of matches should not be permitted where vapors of flammable liquids are present or are likely to be formed.

HOW TO EXTINGUISH GASOLINE AND KEROSENE FIRES [12]

Fires are commonly put out in two ways: (1) By cooling the burning materials to below their burning temperature; and (2) by smothering the fire and thus depriving it of the air (oxygen) necessary to support combustion.

Gasoline and kerosene fires are best extinguished by smothering, as by a foam or gas. The following appliances are recommended for fighting such fires: Foam extinguishers, carbon dioxide extinguishers, vaporizing-liquid extinguishers (carbon tetrachloride base), loaded-stream extinguishers.

Because the effective period of discharge of some of these extinguishers is comparatively short, ranging from 15 to 205 seconds, the operator should be sure that he knows the location of the seat of the fire and that he is sufficiently close before putting the extinguisher into operation. Otherwise the maximum effectiveness of the device will not be obtained.

It is important that only first-aid fire appliances which have been listed by and bear the label of the Underwriters' Laboratories be selected or used and that they be properly operated and maintained.

In using extinguishers of the carbon dioxide and vaporing-liquid types, especially in unventilated places, such as small rooms, closets, or confined spaces, operators and others should guard against breathing the vapors or gases liberated or produced.

As a guide in determining the number and size of extinguishers needed, it is considered that one of the following units would provide protection against a flammable liquid fire which would be apt to occur on the farm. (1) Two 1½-gallon or one 2½-gallon foam extinguishers; (2) four 2-pound, two 4-, 7½-, or 10-pound, or one 15-pound carbon dioxide extinguisher; (3) two 1-, 1¼-, 1½-, or 2-quart vaporizing-liquid extinguishers; (4) two 1¾- or 2½- gallon loaded-stream extinguishers.

[12] Much of the material on this subject is based on the Regulations of the National Board of Fire Underwriters for the Installation, Maintenance, and Use of First Aid Fire Appliances as recommended by the National Fire Protection Association, edition of Oct. 15, 1931, with amendments of 1932.

FOAM EXTINGUISHERS

Most hand extinguishers of the foam type (fig. 6) come in two sizes, 1½-gallon and 2½-gallon.

When an extinguisher of this type is inverted, the two solutions contained in it mix and react, producing a foam under sufficient pressure to furnish a forceful stream. One solution is sodium bicarbonate and a foam-producing agent, and the other is a water solution of

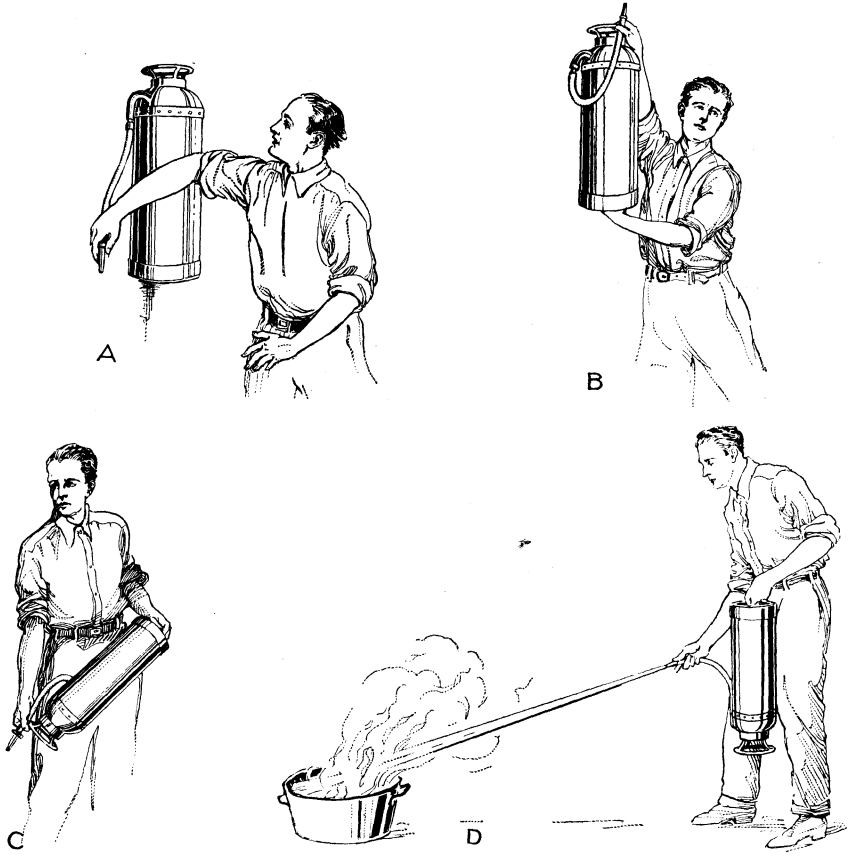

FIGURE 6.—*A*, It is important that the hose be held between the thumb and the index finger of the right hand when bringing the extinguisher into use. *B*, Grasp the ring top with the fingers of the right hand and the bottom with the left hand, then lift the extinguisher off the hanger hook and carry it to the fire. *C*, The extinguisher can now be easily inverted by grasping the bottom handle with the left hand. When the extinguisher is approximately in the position shown, the fingers of the right hand should release the ring top, but should continue to hold the hose. The extinguisher, upside down, the left hand holding the bottom handle, is now in full operation. *D*, The stream should be directed against the inside of the opposite wall of the tank, above the level of the burning liquid. The operator should walk around the fire if possible, and if the fire is on the floor he should stand back and allow the foam to fall on the fire without much force, thereby preventing the spread of the flames.

aluminum sulphate. About 20 gallons of foam are produced by the 2½-gallon extinguisher.

The foam extinguishes a fire by both the cooling and smothering effects. Containing a liberal quantity of water, it has considerable cooling effect. The foam itself smothers the fire by clinging to the burning materials and excluding air (oxygen). This extinguisher is effective on fires in small quantities of flammable liquids in open

vessels or on floors, where the foam may be retained as a blanket on the burning material.

Although the stream is usually most effective when directed from a distance, it may also be used close to the fire. In case of necessity it can be directed effectively from a distance as great as 30 to 40 feet. The foam extinguisher must be protected against freezing.

CARBON DIOXIDE EXTINGUISHERS

The carbon dioxide type of extinguisher (fig. 7) commonly comes in sizes containing 2, 4, 7½, 10, and 15 pounds of carbon dioxide.

From two-thirds to three-fourths of the gas contents in the cylinder is liquefied by pressure. Because of rapid expansion and high heat capacity, this gas, when released, instantly freezes into a dry carbonic snow, which is intensely cold (−110° F). It does not melt, but evaporates directly into a gas. The fire is extinguished by the blanketing effect of the carbonic gas. The carbon dioxide is a nonconductor of electricity.

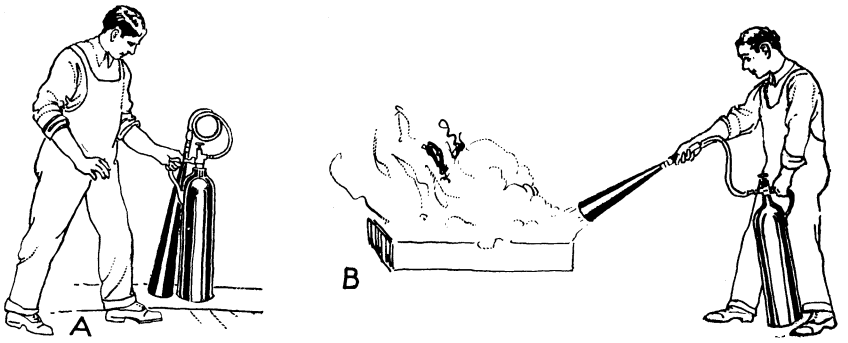

FIGURE 7.—*A*, The extinguisher is removed by grasping the handle with the left hand. It should be carried to the fire by means of the handle. To release the gas the valve is opened by turning it counterclockwise. *B*, Direct the discharge as close to the fire as possible, applying it first at the edge and bottom of the fire and progressing forward and upward, moving the discharge horn slowly from side to side. Continue the discharge even after the fire has been extinguished in order to cool the liquid and prevent possible reflashing.

This type of extinguisher is effective on fires in small quantities of flammable liquids in open vessels or on floors, where the blanketing effect of the extinguishing gas is of value. It has a maximum range of about 8 feet, but best results are obtained by directing the discharge as close to the fire as possible. This extinguisher does not need protection against freezing.

VAPORIZING-LIQUID EXTINGUISHERS (CARBON TETRACHLORIDE BASE)

The most common sizes of the vaporizing-liquid type of extinguisher (fig. 8) are those of 1-, 1¼-, 1½-, and 2-quart capacity. By means of a hand pump, a stream of liquid having a carbon tetrachloride base is expelled on the fire. The heat of the fire causes this liquid to vaporize, producing an incombustible, heavier-than-air gas, which forms a blanket over the burning material, cutting off the supply of air (oxygen) necessary to support combustion. This liquid is a nonconductor of electricity. This type of extinguisher needs no protection against freezing.

The vaporizing-liquid type of extinguisher is effective on fires in small quantities of flammable liquids in open vessels or on floors,

where the gas formed by the heating of the extinguishing liquid may be retained as a blanket on the burning material. Although the stream is usually most effective when used close to the fire, in case of necessity it can be directed from a distance of 20 feet.

LOADED-STREAM EXTINGUISHERS

The loaded-stream extinguisher is made principally in two sizes, 1¾-gallon and 2½-gallon. It is effective on fires in small quantities of flammable liquids in open vessels or on floors. The chemical used is a special antifreeze solution containing certain alkali metal salts. These extinguishers are supplied in two forms. One employs a small carbon dioxide cartridge for expelling the chemical solution; the other employs a special acid contained in a sealed bottle.

This type of extinguisher is operated the same as the foam extinguisher (fig. 6), except that it is bumped on the floor or other hard surface after it is inverted. When the extinguisher is inverted and bumped, the pressure produced or released expels the contents through

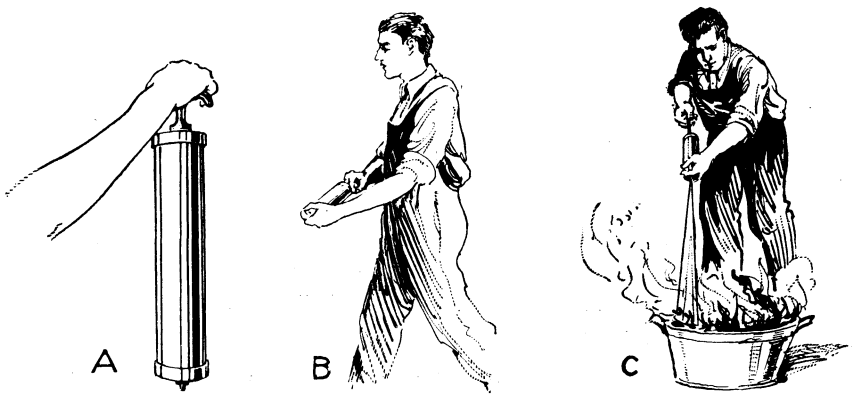

FIGURE 8.—*A*, Remove the extinguisher from the wall bracket by grasping the handle and pulling outward. *B*, On the way to the fire unlock the handle by turning. If the device is of the air-pump type, hold a finger over the nozzle and pump up the pressure. *C*, Direct the stream at the base of the flames and work around the fire rapidly. If the fire is in an open container or tank, direct the stream against the inside of the opposite wall above the level of the burning liquid.

the hose. Although the stream is most effective when used close to the fire, when necessary it can be directed effectively from a distance of 30 to 40 feet. This type of extinguisher needs no protection against freezing.

USE OF SAND, SODA AND SAWDUST, AND WATER

Sand is useful in preventing fires by covering or absorbing spilled flammable liquids. It may also be used in putting out small, isolated fires in flammable liquids on floors.

Sawdust, evenly mixed with sodium bicarbonate in the proportion of 10 pounds of soda to 1 bushel of sawdust, is effective on fires in small quantities of lubricating oils and greases in open vessels or on floors when the mixture is applied rapidly and is spread over the entire surface.

Water is not ordinarily effective in fighting fires in flammable liquids. In fact, its use may make control of the fire more difficult, because the burning liquid may be washed about, spreading the fire over a larger area.

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